CLAIMS

1. A rotary component comprising a rotor having a plurality of teeth arranged around the perimeter of the rotor, each tooth having a crown, and each pair of adjacent teeth having a valley therebetween, the crowns of the teeth lying on a curved envelope forming the perimeter of the rotor, the perimeter of the rotor having a non-circular profile having at least two protruding portions alternating with receding portions,

in which the distance between the midpoints of the crowns of each pair of adjacent teeth is substantially the same, the profile of the valley between each pair of adjacent teeth is substantially the same, and the distance between the midpoint of each crown and the axis of the rotor varies around the perimeter to produce the said non-circular profile.

2. A rotary component according to Claim 1 in which for each tooth the orientation of the valley on one side of the tooth relative to the valley on the other side of the tooth taken about the midpoint of the crown of the tooth varies around the perimeter to produce the said non-circular profile.

3. A rotary component according to any preceding claim in which the midpoints of the crowns of the teeth are positioned respectively at intersections of adjacent sides of a non-regular polygon with equal sides arranged in a non-circular configuration, the position of an intersection V_n of two adjacent sides of the polygon being given by the formula:

$$R_n = L + B\cos\left(2\pi\frac{n}{N}M\right)$$

where:

R_n = distance from an intersection V_n to the centre A of the rotor,

n = the number of the intersection V_n, numbered from a reference intersection at n = 1,

L = the average distance from an intersection V_n to the centre A of the rotor,

B = the desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n or at the least value of R_n,

N = the number of teeth required on the rotor, and

M = the number of protruding portions of the rotor profile.

4. A rotary component comprising a rotor having a plurality of teeth arranged around the perimeter of the rotor, each tooth having a crown, and each pair of adjacent teeth having a valley therebetween, the crowns of the teeth lying on a curved envelope forming the perimeter of the rotor, the perimeter of the rotor having a non-circular profile having at least two protruding portions alternating with receding portions,

in which for each tooth the orientation of the valley on one side of the tooth relative to the valley on the other side of the tooth taken about the midpoint of the crown of the tooth varies around the perimeter to produce the said non-circular profile.

5. A rotary component comprising a rotor having a plurality of teeth arranged around the perimeter of the rotor, each tooth having a crown, and each pair of adjacent teeth having a valley therebetween, the crowns of the teeth lying on a curved envelope forming the perimeter of the rotor, the perimeter of the rotor having a non-circular profile having at least two protruding portions alternating with receding portions,

in which the midpoints of the crowns of the teeth are positioned respectively at intersections of adjacent sides of a non-regular polygon with equal

sides arranged in a non-circular configuration, the position of an intersection V_n of two adjacent sides of the polygon being given by the formula:

$$R_n = L + B\cos\left(2\pi\frac{n}{N}M\right)$$

where:

R_n = distance from an intersection V_n to the centre A of the rotor,

n = the number of the intersection V_n, numbered from a reference intersection at n = 1,

L = the average distance from an intersection V_n to the centre A of the rotor,

B = the desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n or at the least value of R_n,

N = the number of teeth required on the rotor, and

M = the number of protruding portions of the rotor profile.

6. A rotary component according to any preceding claim in which the said non-circular profile is a generally oval profile.

7. A rotary component according to any of Claims 1 to 5, in which the said non-circular profile has three protruding portions arranged regularly around the rotor.

8. A rotary component according to any of Claims 1 to 5, in which the said non-circular profile has four protruding portions arranged regularly around the rotor.

9. A rotary component according to any preceding claim in which the said protruding portions constitute major protruding portions and the said receding portions constitute major receding portions, and the non-circular profile includes

additional minor protruding portions of lesser extent than the major protruding portions.

10. A synchronous drive apparatus including a rotary component according to any preceding claim, the synchronous drive apparatus comprising:

a continuous-loop elongate drive structure having a plurality of engaging sections;

a plurality of rotors comprising at least a first and a second rotor, the first rotor having a plurality of teeth for engaging the engaging sections of the elongate drive structure, and the second rotor having a plurality of teeth for engaging the engaging section of the elongate drive structure;

a rotary load assembly coupled to the second rotor;

the elongate drive structure being engaged about the first and second rotors, the first rotor being arranged to drive the elongate drive structure and the second rotor being arranged to be driven by the elongate drive structure, the rotary load assembly being such as to present a periodic fluctuating load torque when driven in rotation;

in which one of the said first and second rotors is a rotary component according to any preceding claim arranged to reduce or substantially cancel vibration arising from the fluctuating load torque of the rotary load assembly.

11. A synchronous drive apparatus according to Claim 10, in which the said non-circular profile is provided on the first rotor.

12. A synchronous drive apparatus according to Claim 10, in which the said non-circular profile is provided on the second rotor.

13. A synchronous drive apparatus according to Claim 10, in which the non-circular profile is provided on a third rotor.

14. A synchronous drive apparatus according to Claim 13, in which the third rotor comprises an idler rotor urged into contact with the continuous loop elongate drive structure, the third rotor having a plurality of teeth for engaging the engaging sections of the elongate drive structure.

15. A synchronous drive apparatus according to any of Claims 10 to 14, when installed in an internal combustion engine, the said first rotor comprising a crankshaft sprocket.

16. A synchronous drive apparatus according to Claim 15, in which the internal combustion engine is a diesel engine, and the said rotary load assembly comprises a rotary fuel pump.

17. A synchronous drive apparatus according to Claim 15, in which the internal combustion engine is a petrol engine and the rotary load assembly comprises a camshaft assembly.

18. A synchronous drive apparatus according to any of Claims 10 to 17, in which the continuous-loop elongate structure is a toothed belt.

19. A synchronous drive apparatus according to any of Claims 10 to 17, in which the continuous-loop elongate structure is a drive chain.

20. A synchronous drive apparatus according to any of Claims 10 to 19 when dependent upon Claim 9, except when dependent on Claim 3 or Claim 5, in which the said rotary component has the mid points of the crowns of the teeth positioned respectively at intersections of adjacent sides of a non-regular polygon with equal sides arranged in a non-circular configuration, the position of

an intersection V_n of two adjacent sides of the polygon being given by the formula:

$$R_n = L + B_2 \cos\left(2\pi \frac{n}{N} 2\right) + B_4 \cos\left(2\pi \frac{n}{N} 4 + \varphi\right)$$

where:

R_n = distance from an intersection V_n to the centre A of the rotor,

n = the number of the intersection V_n, numbered from a reference intersection at n = 1,

L = the average distance from an intersection V_n to the centre A of the rotor,

B_2 = a first desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n at a major protruding portion or at the least value of R_n at a major receding portion, the first out-of-round factor being such as to reduce or eliminate vibration arising from 2nd order harmonics of the rotary load assembly,

B_4 = a second desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n at a minor protruding portion or at the least value of R_n at a minor receding portion, the second out-of-round factor being such as to reduce or eliminate vibration arising from 4th order harmonics of the rotary load assembly,

N = the number of teeth required on the rotor, and

φ = an angle representing a desired phase shift between 2nd and 4th order vibrations.

21. A method of constructing a rotary component comprising a rotor having a plurality of teeth arranged around the perimeter of the rotor, each tooth having a crown, and each pair of adjacent teeth having a valley therebetween, the crowns of the teeth lying on a curved envelope forming the perimeter of the rotor, the

perimeter of the rotor having a non-circular profile having at least two protruding portions alternating with receding portions;

the method comprising the steps of:

generating a template of a non-regular polygon with equal sides arranged in a non-circular configuration, the position of an intersection V_n of two adjacent sides of the polygon being given by the formula:

$$R_n = L + B\cos\left(2\pi \frac{n}{N} M\right)$$

where:

R_n = distance from an intersection V_n to the centre A of the rotor,

n = the number of the intersection V_n, numbered from a reference intersection at n = 1,

L = the average distance from an intersection V_n to the centre A of the rotor,

B = the desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n or at the least value of R_n,

N = the number of teeth required on the rotor, and

M = the number of protruding portions of the rotor profile;

generating an outline of the teeth to be positioned around the perimeter of the rotor by positioning the centre points of the crowns of the teeth at the points of intersection of the sides of the non-regular polygon; and

constructing the rotary component to have an outer perimeter corresponding to the outline of the teeth generated by reference to the non-regular polygon.

22. A method of constructing a rotary component comprising a rotor having a plurality of teeth arranged around the perimeter of the rotor, each tooth having a crown, and each pair of adjacent teeth having a valley therebetween, the crowns of the teeth lying on a curved envelope forming the perimeter of the rotor, the perimeter of the rotor having a non-circular profile having at least two major protruding portions alternating with major receding portions, and the non-circular profile includes additional minor protruding portions and minor receding portions of lesser extent than the major protruding portions and major receding portions,

the method comprising the steps of:

generating a template of a non-regular polygon with equal sides arranged in a non-circular configuration, the position of an intersection V_n of two adjacent sides of the polygon being given by the formula:

$$R_n = L + B_2 \cos\left(2\pi \frac{n}{N} 2\right) + B_4 \cos\left(2\pi \frac{n}{N} 4 + \varphi\right)$$

where:

R_n = distance from an intersection V_n to the centre A of the rotor,

n = the number of the intersection V_n, numbered from a reference intersection at n = 1,

L = the average distance from an intersection V_n to the centre A of the rotor,

B_2 = a first desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n at a major protruding portion or at the least value of R_n at a major receding portion,

B_4 = a second desired out-of-round factor defined as the difference between the average distance L and the actual distance R_n when taken either at the greatest value of R_n at a minor protruding portion or at the least value of R_n at a minor receding portion,

N = the number of teeth required on the rotor, and

φ = a constant angle selected for a particular use of the rotary component;

generating an outline of the teeth to be positioned around the perimeter of the rotor by positioning the centre points of the crowns of the teeth at the points of intersection of the sides of the non-regular polygon; and

constructing the rotary component to have an outer perimeter corresponding to the outline of the teeth generated by reference to the non-regular polygon.